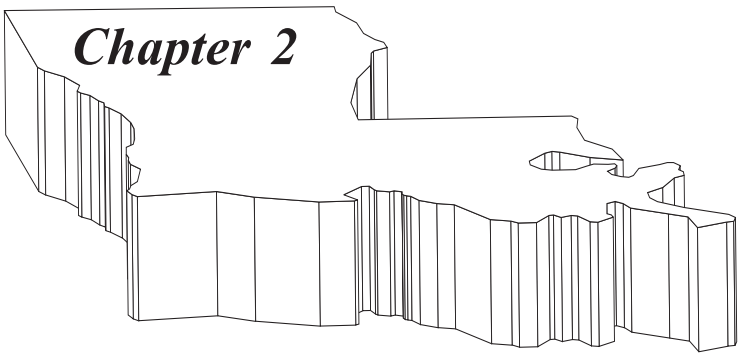
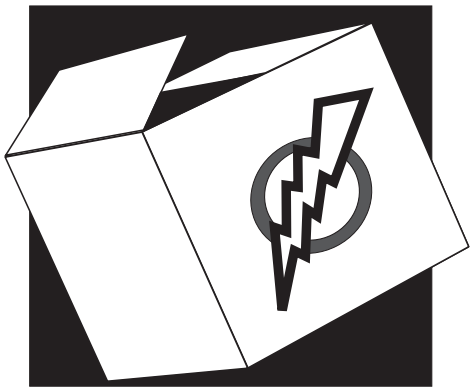




Energy Efficient Packages

Investments in energy efficient features in new construction are remarkable because everyone wins:

- ❒ Most homeowners receive a positive cash flow immediately, at worst case within 1 to 3 years.
- ❒ Homeowners benefit additionally from improved comfort, better indoor quality, reduced moisture problems, and fewer health problems.
- ❒ Builders have fewer callbacks and make additional profit from the extra construction costs.
- ❒ Heating and cooling contractors have fewer callbacks.
- ❒ Realtors receive additional fees from the additional cost of the energy features and enhance their reputation by selling higher quality homes that consumers appreciate.
- ❒ Bankers receive higher mortgage payments and have more secure loans because the homes have lower annual costs of ownership due to the reduced energy bills.
- ❒ National lending agencies, such as the Federal Housing Authority (FHA) and the Veteran's Administration (VA), require some degree of efficiency by mandating that new homes comply with a residential energy code.
- ❒ The local economy benefits as more money stays within the community and local subcontractors and product suppliers make additional income by selling improved energy efficient features.

Achieving Efficiency

Successful, cost effective, energy efficient homes are no accident. They require diligent attention to detail.

Too often, measures that may be easier to market are installed, but key ingredients — such as sealing air leaks and duct leaks — are left undone. The results are homes with unnecessarily high energy bills, comfort and moisture problems, and homeowners who are thoroughly dissatisfied — hardly a positive customer relations situation.

Designing and building a home that uses energy wisely does not mean sacrificing a home's aesthetics or amenities. Homes of any architectural style can meet the requirements of this publication. Any good home design considers the characteristics of a particular site: the local climate, the availability and cost of energy sources, and the lifestyle of the occupants.

Building an energy efficient home does not require special materials or construction skills. However, the quality of basic construction has a major influence on building comfort and energy costs, especially:

- ❒ Quality of framing and installation of insulation and windows.
- ❒ Attention to detail in sealing air leaks.
- ❒ Design and installation of the heating and cooling equipment.
- ❒ Effectiveness of sealing duct leaks.

Successful builders of energy efficient homes realize the importance of quality. They also know that achieving low energy costs and greater comfort in today's competitive marketplace requires careful planning throughout the design and construction process.

Table 2-1 shows the additional components and their estimated costs for a typical high performance home. Major additional costs are for increased insulation, air sealing, duct insulation and sealing, higher efficiency heating and cooling systems, more efficient lighting, and an improved ventilation system.

Table 2-2 shows the projected financial savings for a "high performance" home. The cumulative net savings are over $14,000 over a 30-year period. The investment begins providing a positive cash flow in the second year, once the additional downpayment for the energy features, added into the first year's extra mortgage, has been paid. (Energy costs are assumed to escalate 2% per year.)

Table 2-2
Savings for a 5-Star Home
(for a 2,000-sq ft home in Baton Rouge)

Code Home		Five-Star Home			
Year	Annual Energy Cost	Extra Mortgage Cost*	Annual Energy Cost	Total Cost	Cumu-. lative Savings
1	1,843	710	1,258	1,968	-125
2	1,880	217	1,283	1,500	254
3	1,917	217	1,309	1,526	646
4	1,956	217	1,335	1552	1050
5	1,995	217	1,362	1,579	1,466
10	2,203	217	1,503	1,720	3,742
15	2,432	217	1,660	1,877	6,368
20	2,685	217	1,832	2,050	9,381
25	2,964	217	2,023	2,240	12,820
30	3,273	217	2,234	2,451	16,729

*The extra mortgage costs are for financing energy efficient features. The first year costs are higher because they include the additional downpayment. Energy costs are assumed to increase 2% per year. The home has a partial slab floor and a partial framed floor over a pier foundation.

Table 2-1
Estimated Extra Costs of 5-Star Homes*

For a 2,000 sq. ft. home in Baton Rouge			
	Quantity	Unit Cost	Total Estimated Cost
Attic -- increase insulation from R-19 to R-30	1,000 sq ft	$0.10/sq ft	100
Cathedral Ceiling -- increase insulation from R-19 to R-25	600 sq ft	$0.20/sq ft	120
Energy efficient framing details (no extra cost)			
Walls and band joist -- R-13 in place of R-11, 1/2" foam sheathing in place of OSB; install let-in bracing; seal band joists and insulate with R-19	2404 sq ft	$0.12/sq ft	288
Insulate floor to R-19 (from uninsulated condition)	630 sq ft	$0.50/sq ft	315
Windows -- install double-paned vinyl units (U-value of 0.50) in place of single-paned wood windows	346 sq ft	$1.50 /sq ft	519
Air leakage -- completely seal all bypasses and penetrations between unconditioned and conditioned spaces	2000 sq ft	$0.1 /sq ft	200
Heating and cooling system -- size for home, ensure quality installation, design duct system, check for proper air flow, consider higher efficiency heating	1 unit	$150 each	150
Cooling efficiency -- select SEER 12 air conditioners in place of SEER 10 units	1 unit	$250 each	250
Charge cooling/ heat pump systems per manufacturer's instructions; locate unit where air can circulate freely	1 unit	$ 50 each	50
Install water heater wrap on water heater	1 unit	$30 each	30
Replace about half of incandscent lamps with compact fluorescent lighting	6 lamps	$20 / lamp	120
Seal all supply and return duct systems	1 unit	$175 each	175
Insulate ductwork to R-6	400/ sq ft	$0.20/ sq ft	80
Install improved ventilation fans; add dampered duct for fresh make-up air for ventilation system	1 system	$100 each	100
Lengthen overhangs/ install shade screens on east and west	330	$2/ sq ft	660
More efficient clothes washer, cooking appliances, refrigerator	4	$100 each	400
COST SUBTOTAL			**3,557**
Reduction in heating and cooling system cost			**(1,097)**
NET TOTAL COST			**$ 2,460**

* The dimensions are for a home that is partially 1-story and partially 2-story to seek an average cost increment for this size of home.

Table 2-3
Minimum Designs that Meet the Model Energy Code

City	Glazing Area Percent	Glazing U-value	Ceiling R-Value	Wall R-Value	Floor R-Value	Slab Perimeter R-Value	Crawl Space Wall R-Value
Lafeyette, Lake Charles, New Orleans and areas with 1,500 to 1,999 heating degree days							
	8%	Any	R-19	R-11	R-11	R-0	R-5
	12%	0.75	R-19	R-11	R-11	R-0	R-5
	15%	0.75	R-26	R-13	R-11	R-0	R-5
	18%	0.65	R-30	R-13	R-11	R-0	R-5
	20%	0.60	R-30	R-13	R-11	R-0	R-5
	25%	0.52	R-30	R-13	R-13	R-0	R-6
Shreveport, Monroe, Alexandria and areas with 2,000 to 2,499 heating degree days							
	8%	0.90	R-19	R-11	R-11	R-0	R-6
	12%	0.65	R-19	R-13	R-11	R-0	R-5
	15%	0.65	R-30	R-13	R-11	R-0	R-6
	18%	0.55	R-30	R-13	R-11	R-0	R-6
	20%	0.52	R-38	R-13	R-11	R-0	R-6
	25%	0.50	R-38	R-13	R-19	R-0	R-10
Ruston and areas with 2,500 to 2,999 heating degree days							
	8%	0.70	R-26	R-11	R-11	R-0	R-6
	12%	0.60	R-26	R-13	R-13	R-0	R-5
	15%	0.60	R-30	R-13	R-19	R-0	R-7
	18%	0.52	R-30	R-13	R-19	R-4	R-7
	20%	0.50	R-38	R-13	R-19	R-0	R-7
	25%	0.46	R-58	R-13	R-19	R-0	R-7

THE MODEL ENERGY CODE

The Model Energy Code is a national code developed by the Council of American Building Code Officials. The code has requirements for:

- ❒ Thermal insulation
- ❒ Air sealing
- ❒ HVAC system design
- ❒ Hot water conservation
- ❒ Duct insulation and sealing

The Model Energy Code was the starting point for development of the International Energy Conservation Code (IECC). Many states around the country are now adopting the IECC 2000.

Table 2-3 shows combinations that comply with the IECC 2000. The table shows that using R-30 as a standard for ceiling insulation provides room for trade-offs with other aspects of the home. For example, in New Orleans some packages require less than R-30 in attics. Homes with R-30 could trade-off the extra insulation for greater window area or less insulation elsewhere.

Wall R-values and glazing U-values prescribed in Table 2-3 depend largely on geographical locations and the percentage of total wall area occupied by windows. The window percentage represents the ratio of the total area of all glazing area, including windows, sliding glass doors, glass in door units, and basement windows, to the total wall area. For example, a home with 2,000 square feet of total exterior wall area and 15% window area

will have 300 square feet of glazing area (2,000 sq ft x 15% = 300 sq ft.)

The window's insulating values are reported as U-values because the National Fenestration Rating Council (NFRC), whose labels appear on many windows sold in the United States, and other organizations use this measure rather than its opposite -- the R-value. R-values measure the resistance to heat flow. The U-value, which measures how well a material conducts heat, is the reciprocal of R-value — U-value = 1/R-value.

Typical industry average window U-values are:

Single-glazed windows	U - 1.10
Double-glazed	
metal — no thermal break	U - 0.78
metal — thermal break	U - 0.62
wood frame or wood with vinyl or metal cladding	U - 0.55
Double-glazed	
Low-e	U - 0.37
Low-e with inert gas fill	U - 0.31
Triple-glazed low-e with inert gas fill	U - 0.26
Quad-glazed low-e with inert gas fill	U - 0.20

- ❒ Wall R-values are the sum of cavity insulation plus sheathing -- not including siding, structural sheathing, or interior drywall.
- ❒ Ceiling R-values represent the sum of cavity insulation plus any sheathing.
- ❒ Floor requirements apply to floors over unconditioned crawlspaces, basements, and garages; however, cantilevered floors and other floors over outside air must meet ceiling requirements.
- ❒ Crawlspace wall R-value requirements are for walls of unvented crawlspaces, extending from the top of the wall to at least 12 inches below the outside finished grade.

MECcheck is a simplified approach to determine compliance with residential energy codes. It was developed by Pacific Northwest National Labs (PNNL). The software performs trade-offs between building components including heating and cooling system efficiency. The software can be downloaded at http://www.energycodes.gov.

Evaluating Energy Efficient Products

The energy efficient builder seeks to minimize the lifetime costs of a home rather than the first cost. Making such calculations is often time-consuming and confusing. One of the best ways to determine whether an investment is sound is to compare the annual energy savings with the additional annual mortgage costs to find the Net Annual Savings.

Simple Payback

For example, suppose you are wondering whether it is worthwhile to install efficient, low-e windows which use special coatings to reduce heat loss and gain. You receive the following information comparing low-e windows to double-glazed windows from a window dealer:

- ❒ Additional Window Cost = $500
- ❒ First Year Energy Savings = $75

You can easily calculate that the simple payback period on the above investment is just under 7 years (500/75). However, you are unsure whether the payback is acceptable.

Net Annual Savings

To find the Net Annual Savings, find the extra mortgage costs for the windows:

- ❒ Mortgage Interest Rate = 8.0%
- ❒ Term of Mortgage = 30 years
- ❒ Monthly Payment per $1,000 (from Table 2-5) = $7.69
- ❒ Annual Payment per $1,000 (Monthly payment x 12 months/year) = $7.69 * 12 = $92.28 per year for $1,000 of principal
- ❒ Extra Annual Payment (multiply the additional cost of the windows by the above factor/1,000) = $500 * $92.28/$1,000 = $46 per year payment
- ❒ Net Annual Energy Savings (subtract the annual payment from annual energy savings) = $75 - $46 = $29

Since the Net Annual Energy Savings is positive, the investment is sound, especially when considering that energy costs will increase over time, while mortgage costs will remain relatively constant.

Internal Rate of Return

It is often useful to calculate the Internal Rate of Return (IRR) for an energy investment. Homeowners can compare the annual return from an energy measure to that earned by a typical financial investment at a bank. To find the IRR for the above example:

1. Find the payback period (divide the total cost by the annual savings) = 500/75 = about 7 years.

2. Determine the life of the energy measure = over 20 years.

3. To find the IRR, locate the row in Table 2-4 for the 7-year payback; then slide across to the 20-year column and find the IRR, which is 15% in this example(and it's tax free).

Table 2-4
Rate of Return for Energy Investments (%)

Simple Payback	Lifetime of Energy Investments (Years)			
	5	10	15	20
1.5	62%	68%	69%	69%
2	43%	51%	52%	52%
3	21%	33%	35%	35%
4	9%	23%	26%	27%
5	1%	17%	20%	21%
6	0%	12%	16%	18%
7	0%	9%	13%	15%
8	0%	6%	11%	13%
9	0%	4%	9%	11%
10	0%	2%	7%	10%
11	0%	0%	6%	8%
12	0%	0%	5%	7%
13	0%	0%	4%	6%
14	0%	0%	3%	6%
15	0%	0%	2%	5%
16	0%	0%	1%	4%
17	0%	0%	0%	3%
18	0%	0%	0%	3%
19	0%	0%	0%	2%
20	0%	0%	0%	2%

Note: A zero indicates the rate of return is either negligible or negative. Energy prices are assumed to escalate 2%/ year.

MORTGAGE RATE TABLES

The following tables show the monthly payment for principal and interest for a $1,000 loan at various interest rates and amortization periods. According to the chart, a mortgage of 20 years at 10% annual interest would have monthly payments of $9.65 per $1,000 of principal or 12 x 9.65 = $115.80 per year of payments per $1,000 of principal. If the extra energy features of a home cost an additional $2,500, the extra annual mortgage would be $2,500 x $115.80 / $1,000 = $289.50.

This approach is useful in comparing different methods of financing construction loans and permanent mortgages and their effect on the economics of energy efficient construction techniques.

Table 2-5
Mortgage Rate Table 1*

Years of Amortization	Interest Rate 5.00	5.25	5.50	5.75	6.00	6.25	6.50	6.75	7.00	7.25	7.50	7.75	8.00
5	18.87	18.99	19.10	19.22	19.33	19.45	19.57	19.68	19.80	19.92	20.04	20.16	20.28
7	14.13	14.25	14.37	14.49	14.61	14.73	14.85	14.97	15.09	15.22	15.34	15.46	15.59
10	10.61	10.73	10.85	10.98	11.10	11.23	11.35	11.48	11.61	11.74	11.87	12.00	12.13
15	7.91	8.04	8.17	8.30	8.44	8.57	8.71	8.85	8.99	9.13	9.27	9.41	9.56
17	7.29	7.42	7.56	7.69	7.83	7.97	8.11	8.25	8.40	8.54	8.69	8.83	8.98
20	6.60	6.74	6.88	7.02	7.16	7.31	7.46	7.60	7.75	7.90	8.06	8.21	8.36
25	5.85	5.99	6.14	6.29	6.44	6.60	6.75	6.91	7.07	7.23	7.39	7.55	7.72
30	5.37	5.52	5.68	5.84	6.00	6.16	6.32	6.49	6.65	6.82	6.99	7.16	7.34

*Monthly mortgage payments per $1,000 of principal

Mortgage Rate Table 2*

Years of Amortization	Interest Rate 8.25	8.50	8.75	9.00	9.25	9.50	9.75	10.00	10.25	10.50	10.75	11.00	11.25
5	20.40	20.52	20.64	20.76	20.88	21.00	21.12	21.25	21.37	21.49	21.62	21.74	21.87
7	15.71	15.84	15.96	16.09	16.22	16.34	16.47	16.60	16.73	16.86	16.99	17.12	17.25
10	12.27	12.40	12.53	12.67	12.80	12.94	13.08	13.22	13.35	13.49	13.63	13.78	13.92
15	9.70	9.85	9.99	10.14	10.29	10.44	10.59	10.75	10.90	11.05	11.21	11.37	11.52
17	9.13	9.28	9.43	9.59	9.74	9.90	10.05	10.21	10.37	10.53	10.69	10.85	11.02
20	8.52	8.68	8.84	9.00	9.16	9.32	9.49	9.65	9.82	9.98	10.15	10.32	10.49
25	7.88	8.05	8.22	8.39	8.56	8.74	8.91	9.09	9.26	9.44	9.62	9.80	9.98
30	7.51	7.69	7.87	8.05	8.23	8.41	8.59	8.78	8.96	9.15	9.33	9.52	9.71

*Monthly mortgage payments per $1,000 of principal

Mortgage Rate Table 3*

Years of Amortization	Interest Rate 11.50	11.75	12.00	12.25	12.50	12.75	13.00	13.25	13.50	13.75	14.00	14.25	14.50
5	21.99	22.12	22.24	22.37	22.50	22.63	22.75	22.88	23.01	23.14	23.27	23.40	23.53
7	17.39	17.52	17.65	17.79	17.92	18.06	18.19	18.33	18.46	18.60	18.74	18.88	19.02
10	14.06	14.20	14.35	14.49	14.64	14.78	14.93	15.08	15.23	15.38	15.53	15.68	15.83
17	11.18	11.35	11.51	11.68	11.85	12.02	12.19	12.36	12.53	12.70	12.87	13.05	13.22
20	10.66	10.84	11.01	11.19	11.36	11.54	11.72	11.89	12.07	12.25	12.44	12.62	12.80
25	10.16	10.35	10.53	10.72	10.90	11.09	11.28	11.47	11.66	11.85	12.04	12.23	12.42
30	9.90	10.09	10.29	10.48	10.67	10.87	11.06	11.26	11.45	11.65	11.85	12.05	12.25

*Monthly mortgage payments per $1,000 of principal

Table 2-5 (continued)
Mortgage Rate Table 4*

Years of Amortization	Interest Rate 14.75	15.00	15.25	15.50	15.75	16.00	16.25	16.50	16.75	17.00	17.25	17.50	17.75
5	23.66	23.79	23.92	24.05	24.19	24.32	24.45	24.58	24.72	24.85	24.99	25.12	25.26
7	19.16	19.30	19.44	19.58	19.72	19.86	20.00	20.15	20.29	20.44	20.58	20.73	20.87
10	15.98	16.13	16.29	16.44	16.60	16.75	16.91	17.06	17.22	17.38	17.54	17.70	17.86
15	13.83	14.00	14.17	14.34	14.51	14.69	14.86	15.04	15.21	15.39	15.57	15.75	15.92
17	13.40	13.58	13.75	13.93	14.11	14.29	14.47	14.65	14.84	15.02	15.20	15.39	15.57
20	12.98	13.17	13.35	13.54	13.73	13.91	14.10	14.29	14.48	14.67	14.86	15.05	15.24
25	12.61	12.81	13.00	13.20	13.39	13.59	13.79	13.98	14.18	14.38	14.58	14.78	14.97
30	12.44	12.64	12.84	13.05	13.25	13.45	13.65	13.85	14.05	14.26	14.46	14.66	14.8

*Monthly mortgage payments per $1,000 of principal

Mortgage Rate Table 5*

Years of Amortization	Interest Rate 18.00	18.25	18.50	18.75	19.00	19.25	19.50	19.75	20.00	20.25	20.50	20.75	21.00	21.25
5	25.39	25.53	25.67	25.80	25.94	26.08	26.22	26.35	26.49	26.63	26.77	26.91	27.05	27.19
7	21.02	21.16	21.31	21.46	21.61	21.76	21.91	22.06	22.21	22.36	22.51	22.66	22.81	22.96
10	18.02	18.18	18.34	18.50	18.67	18.83	19.00	19.16	19.33	19.49	19.66	19.83	19.99	20.16
15	16.10	16.28	16.47	16.65	16.83	17.01	17.19	17.38	17.56	17.75	17.93	18.12	18.31	18.49
17	15.76	15.94	16.13	16.32	16.50	16.69	16.88	17.07	17.26	17.45	17.64	17.83	18.02	18.22
20	15.43	15.63	15.82	16.01	16.21	16.40	16.60	16.79	16.99	17.18	17.38	17.58	17.78	17.97
25	15.17	15.37	15.57	15.78	15.98	16.18	16.38	16.58	16.78	16.99	17.19	17.39	17.60	17.80
30	15.07	15.28	15.48	15.68	15.89	16.09	16.30	16.50	16.71	16.92	17.12	17.33	17.53	17.74

*Monthly mortgage payments per $1,000 of principal

HOME ENERGY PACKAGES

A well designed energy efficient home requires close attention to detail on the part of the builder and designer. Insulation and high quality windows are not enough; to seek out and eliminate energy waste, the homebuilder must have a well planned approach with careful management of the details.

The designer and builder should compare the initial cost of features to long-term energy savings. Successful builders realize that efficiency not only saves money, but also improves the quality, comfort, and durability of the home. Quality construction reduces the builder's risk and liability; comfort provides a satisfied customer; and durability means fewer call backs and higher profits.

A ***Home Energy Package*** is a planning and marketing tool that can prove invaluable to those involved in home construction and sales. The four packages are:

- ❒ **Code** — The insulation components meet the Model Energy Code, but the builder did not pay substantial attention to air sealing, duct sealing, or installation of the heating and cooling systems.
- ❒ **5-Star** — A modest effort beyond standard energy conservation measures which can save up to 30 percent on energy bills.
- ❒ **5-Star Plus** — An aggressive program that can reduce energy costs as much as 60 percent compared to standard energy conserving homes.
- ❒ **5-Star/ Passive Solar** — A sound energy efficiency program which also incorporates additional south-facing glazing and thermal mass to reduce heating needs.

Table 2-6
Economic Analysis of Energy Efficient Packages*

	Annual Energy Costs ($)			
	Code Home	Five-Star Home	Five-Star Plus	Passive Solar Home**
Heating	444	224	113	135
Cooling	563	290	183	320
Hot Water	396	366	171	220
Lighting	84	56	42	56
Other (Appliances; Service Charges)	356	321	289	321
Total	**1,843**	**1,258**	**798**	**1,052**
Annual Energy Savings		**585[1]**	**1,045[1]**	**791[1]**
Typical Additional Construction Costs		**2,466[1]**	**5,635[1]**	**5,466[1]**
Extra Mortgage ($/yr) (8% loan for 30 years)		**217[1]**	**496[1]**	**481[1]**
Payback Period (years)		**4.2**	**5.4**	**6.9**
Estimated Rate of Return (IRR)		**53%[1]**	**42%[1]**	**29%[1]**

* For a two-story, 2,000-square-foot home in Baton Rouge

** Includes extra cost of 5-Star Home features, additional south-facing glass, and thermal mass

[1] Compared to Code Home

The energy packages go beyond simple conservation measures. They specify framing and insulation details, window location, heating and cooling system design, appliance efficiency, lighting, water heating, shading, and ventilation. Many experts call homes built to these standards *high performance homes*. The features, costs, and energy savings of the different packages are compared in Table 2-6 and Table 2-7.

The energy efficient packages provide an excellent investment to the homeowner — the energy savings exceed the extra annual mortgage costs incurred to pay for the energy features from the first year on. Thus, even when considering the additional downpayment for the energy features, the investment pays off within two years -- and often during the first year.

The builder must pay special attention to all of the details for the Energy Packages. The remainder of this publication describes the materials and techniques required for successful construction of a high performance home.

Table 2-7
Energy Efficient Home Packages *

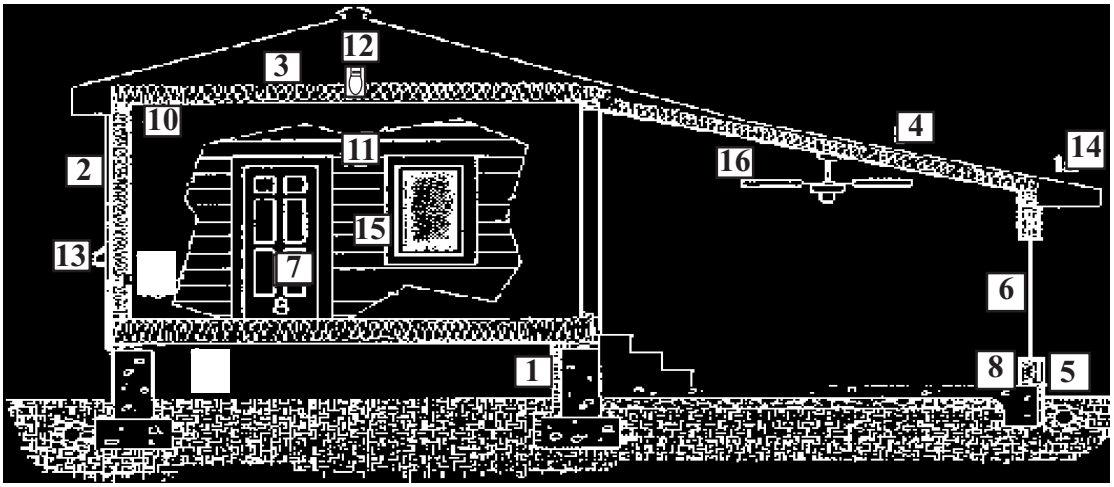
Home Energy Rating ---------->	Standard (Code) (80 pts)	Energy 1 (5-Star) (86 pts.)	Energy 2** (5-Star Plus) (92 pts)
Insulation & Infiltration Control			
Ceiling insulation	R-19	R-30	R-38
Cathedral ceiling insulation	R-19	R-25	R-30
Wall insulation (including sheathing)	R-11.5	R-15.5 to 16.6	R-21.5 to 25.6
Floor Insulation	None	R-19	R-19
Framing details	Standard	Energy efficient framing details	Energy efficient framing details
Moisture control	Minimal	Measures described in Chapter 1	Same as Energy 1
Infiltration control	Basic	Continuous Air Barrier System	Continuous Air Barrier System
Windows and Doors			
Windows	Single-glazed	Double-glazed, thermally insulated vinyl or wood	Double-glazed, low-emissivity
Doors	Wood	R-4 or better	R-4 or better
Heating, Cooling and Ventilation Systems			
Furnace (AFUE)	0.78	0.80	0.90
Heat pump (HSPF)	6.8	7.0	8.0
Air conditioner (SEER)	10.0	11.0	15.0
Ventilation	None	Upgraded spot ventilation with make-up air	Same as 5-Star Home
Thermostat	Standard	Programmable***	Programmable***
Ductwork	Standard — 15% leakage	Ducts sealed (max 3% leakage), R-6 insulation	Ducts located in conditioned space
Water Heating			
Water heater efficiency	Standard	Moderate efficiency	High efficiency
Water heating conservation	None	Low-flow showerheads, pipe insulation	Same as Energy 1
Lighting	12 Incandescent/ 3 Fluorescent/ Standard exterior	6 Incandescent/ 9 Fluorescent/ Efficient exterior	3 Incandescent/ 12 Fluorescent/ Efficient exterior
Appliances	Standard	Efficient cooking, refrigeration and clothes washing	All appliances efficient
Natural Cooling			
Overhang above south-facing windows	1/2 foot	2 feet	2 feet
Window shading treatments	None	Exterior shade screen on west windows	Exterior shade screen on south, east, and west

* Comparisons are based on a two-story, 2,000-square foot home.

** The Passive Solar Design package has the same energy conservation features as the Energy 2 package. In addition, the Passive Solar Design package has a solar water heater and special measures for collecting and storing solar heat in winter.

*** Make certain programmable thermostats are designed for the specific HVAC systems, especially for heat pumps.

Figure 2-1
Energy 1 Package
5-Star Home



Energy 1 Package -- 5-Star Home

ENVELOPE

1. R-19 floor insulation over crawlspace or basement, or against crawlspace walls; no slab insulation until termite problems are solved.
2. 2x4 stud wall with R-13 insulation with no voids and 1/2-inch insulated sheathing; R-19 attic knee wall insulation.
3. R-30 attic insulation with adequate ventilation.
4. R-25 cathedral ceiling insulation with adequate ventilation.
5. Complete insulation coverage between all conditioned and unconditioned areas.

WINDOW AND DOOR

6. Double-glazed windows with wood frames or metal with thermal breaks; maximum infiltration rating of 0.30 cfm per foot of operable sash; minimize east and west windows; avoid skylights.
7. R-4 or better insulated exterior doors with a maximum infiltration rating of .5 cfm per square foot of door area; front door may be solid wood.

AIR TIGHT / VENTILATE RIGHT

8. Seal under bottom plate in conditioned area; seal all wiring, plumbing, and ductwork penetrations.
9. If fireplaces are used, all have tight fitting glass doors, outside combustion air, and flue dampers; seal between framing and chimney with noncombustible firestopping.
10. Use continuous air barrier system, as described in Chapter 4.
11. Seal rough openings for windows and doors with non-expanding foam sealant.
12. Recessed lights must be UL-approved IC (insulation contact) fixtures; they must also be airtight -- rated for less than 2 cubic feet per minute of air leakage under test conditions. Seal bypasses through chases, dropped soffits, stairwells, split levels, and tongue-in-groove ceilings.
13. Exhaust fans have low sone ratings for sound and deliver 50 cfm per bathroom and 100 cfm in the kitchen; all fans are vented to the outside (not into the attic) and can be controlled with a timer switch. Install dampered fresh air make-up air duct into HVAC system.

NATURAL COOLING

14. Shade south windows with 2-foot overhang or solar shading treatments.
15. Shade southwest and west windows with solar shade screens, awnings, interior roller blinds, reflective coatings, or landscaping.
16. Install ceiling fans in frequently used rooms, including bedrooms.

HEATING AND COOLING

17. Air conditioner has SEER of 11 to 12.
18. Heat pump has minimum HSPF of 7 and minimum SEER of 11.
19. Furnace has minimum AFUE of .80 .
20. System and ductwork sized and designed by a qualified professional; system charged properly.
21. Minimize ductwork in unconditioned areas; insulate ductwork to R-4.3 in conditioned spaces (minimum R-6 in unconditioned spaces).
22. Programmable thermostat designed for specific equipment and located properly.

DOMESTIC HOT WATER

23. Moderate efficiency water heater with foam insulation; if electric water heater, consider using a heat pump water heater or desuperheater.
24. Install low-flow showerheads; insulate first four feet of all water pipe from water heater; set thermostat at 120° F; install heat traps on piping to eliminate convective loops. Insulate all exposed water piping for freeze protection.

APPLIANCES AND LIGHTING

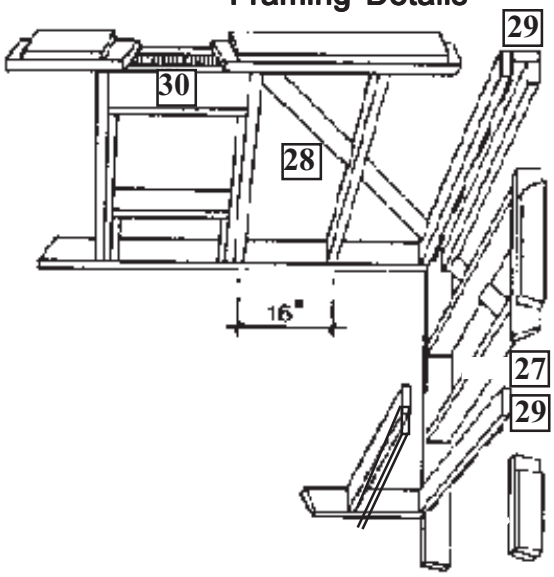
25. Moderate energy efficient refrigerator, dishwasher, range, washer, dryer, and television.
26. Fluorescents used for area lighting in rooms; high intensity discharge lamps (high pressure sodium or metal halide) for exterior lighting.

FRAMING DETAILS

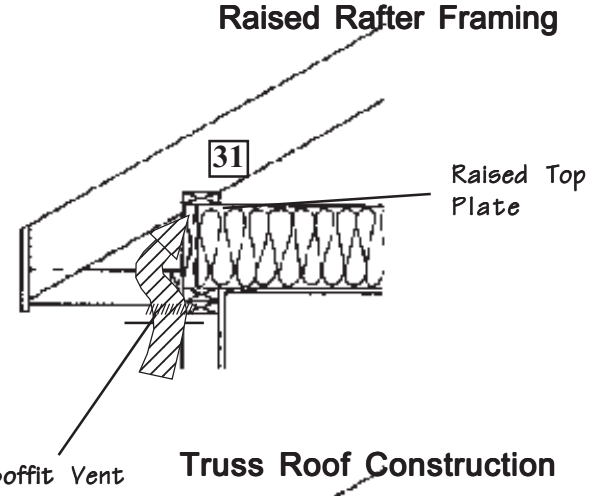
27. Limit blocking in exterior 2x4 walls.
28. Use let-in bracing and insulated sheathing in place of plywood sheathing in corners.
29. Use energy efficient details instead of boxed corners or partition wall intersections.
30. Install 1/2-inch rigid insulation in place of plywood in headers.
31. Frame roof to provide clearance at eaves for R-30 (R-38 in north Louisiana) insulation and a one-inch ventilation space above.

Comparing 5-Star Home to Code Home (2,000 square feet in Baton Rouge)	
Extra Construction Costs	$2,466
Additional Cost on Annual Mortgage (8% for 30 years)	$217
Annual Energy Savings	$585
Annual Internal Rate of Return	53%

Figure 2-2
Framing Details



Raised Rafter Framing



Truss Roof Construction

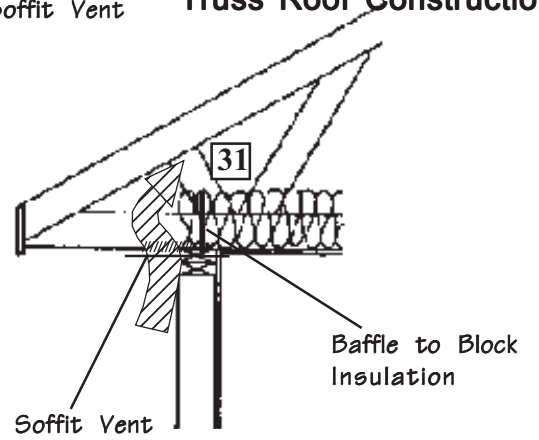
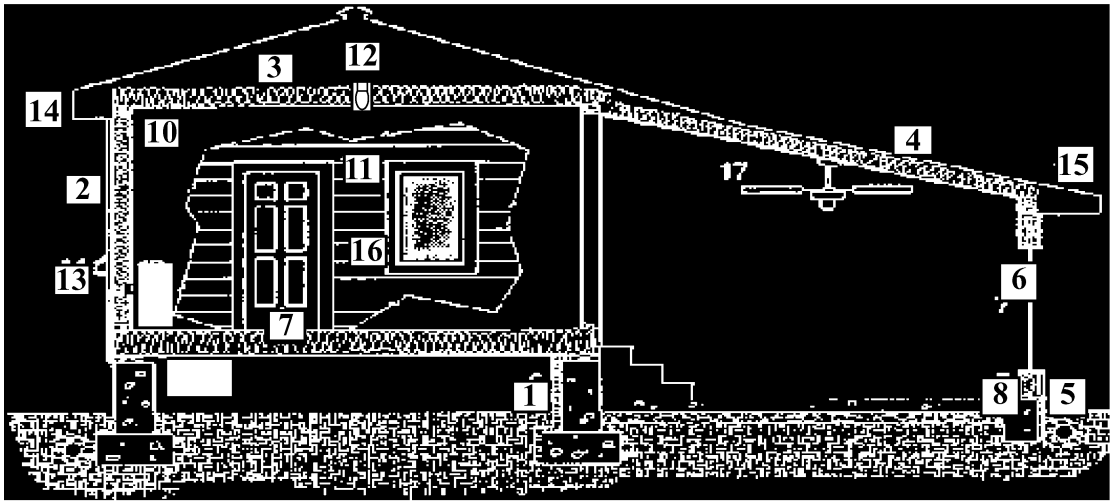


Figure 2-3
ENERGY 2 Package
5-Star Plus Home



Energy 2 Package -- 5-Star Plus Home

(Items below in bold type are changes from Energy 1)

ENVELOPE

1. R-19 floor insulation over crawlspace or basement, or against crawlspace walls; no slab insulation until termite problems are solved.
2. **2x6** stud wall with **R-19** to **R-21** insulation installed with no voids and 1/2-inch insulated sheathing if justified by economic analysis (See pages 84-85.); R-19 knee wall insulation **with radiant heat barrier backing; R-30 sealed band joist.**
3. **R-38 attic insulation or** R-30 attic insulation **with radiant heat barrier.**
4. **R-30 cathedral ceiling insulation or R-24 insulation with radiant heat barrier.**
5. Complete insulation coverage between all conditioned and unconditioned areas.

WINDOW AND DOOR

6. Double-glazed**, low-emissivity, inert gas-filled windows** with a maximum infiltration rating of **0.20** cfm per foot of operable sash. Minimize east and west windows; avoid skylights.
7. R-4 insulated exterior doors. Double weatherstripping and energy efficient thresholds; door infiltration rating less than 0.35 cfm per linear foot. Front door may be built of solid wood.

AIR TIGHT / VENTILATE RIGHT

8. Seal under bottom plate in conditioned area, seal all wiring, plumbing, and ductwork penetrations and all other bypasses in the building envelope.
9. If fireplaces are used, all have tight fitting glass doors, outside combustion air, and dampers.
10. Install continuous air barrier (see Chapter 4).
11. Seal rough openings for windows and doors with non-expanding foam sealant.
12. Recessed lights must be UL approved IC (insulation contact) fixtures; they must also be airtight—rated for less than 2 cubic feet per minute of air leakage under test conditions.
13. Provide tight-fitting dampers for exhaust vents.
14. Exhaust fans have low sone ratings for sound and deliver 50 cfm per bathroom and 100 cfm in the kitchen; all fans are vented to the outside (not into the attic) and can be controlled with a timer switch. Install ventilation system with heat and moisture recovery equipment.

NATURAL COOLING

15. Shade south windows with 2-foot overhang or solar shading treatment.
16. Shade **south, southeast, east**, southwest, and west windows with solar shade screens, awnings, interior roller blinds, reflective coatings, or landscaping.
17. Install ceiling fans in frequently used rooms.

HEATING AND COOLING

18. Homes with slab-on-grade and no slab insulation Air conditioner has a minimum **SEER of 15.0;** Heat pump has a minimum **HSPF of 8.0** and minimum **SEER of 15.0.**
19. Homes with insulated floors over unconditioned spaces or open air--Air conditioner has minimum **SEER of 13.0**; Heat pump has minimum **HSPF of 7.8** and minimum **SEER of 13.0.**
20. Furnace has minimum **AFUE of .90.**
21. System sized properly and ducts designed by a professional and sealed with mastic.
22. **No ductwork in unconditioned areas;** insulate ductwork to R-4.3 in conditioned spaces (minimum R-6 in unconditioned spaces).
23. Programmable thermostat designed for specific equipment and located properly.

DOMESTIC HOT WATER

24. **High efficiency** water heater: Fuel-fired — **Energy Factor exceeds 0.80** Electric — **heat pump water heater, desuperheater, or solar water heater.**
25. Install low-flow showerheads; insulate first four feet of all water pipes from water heater; set thermostat at 120° F; install heat traps on water heater piping to eliminate convective loops.

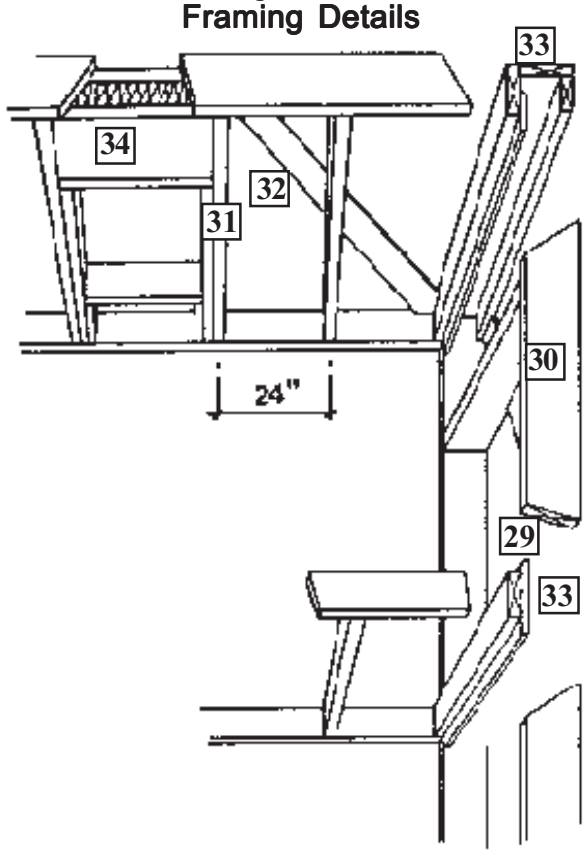
APPLIANCES AND LIGHTING

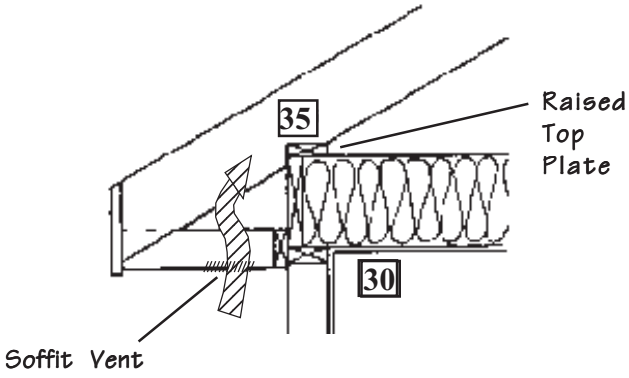
26. **Moderate to high efficiency** refrigerator, dishwasher, range,clothes washer, dryer, televisions, computer equipment.
27. Fluorescents used for area lighting in rooms
28. High intensity discharge lamps (high pressure sodium or metal halide) for exterior lighting.

FRAMING DETAILING

29. Limit blocking in exterior walls.
30. **Use single top plate,** if possible.
31. **Consider using framing alternatives for window and door jambs.**
32. Use let-in bracing and insulated sheathing in place of plywood sheathing in corners.
33. Use energy efficient details instead of boxed corners or partition wall intersections.
34. **Insulate boxed header.**
35. Frame roof to provide clearance at eaves for R-30 insulation and a one-inch ventilation space above.

Figure 2-4
Framing Details



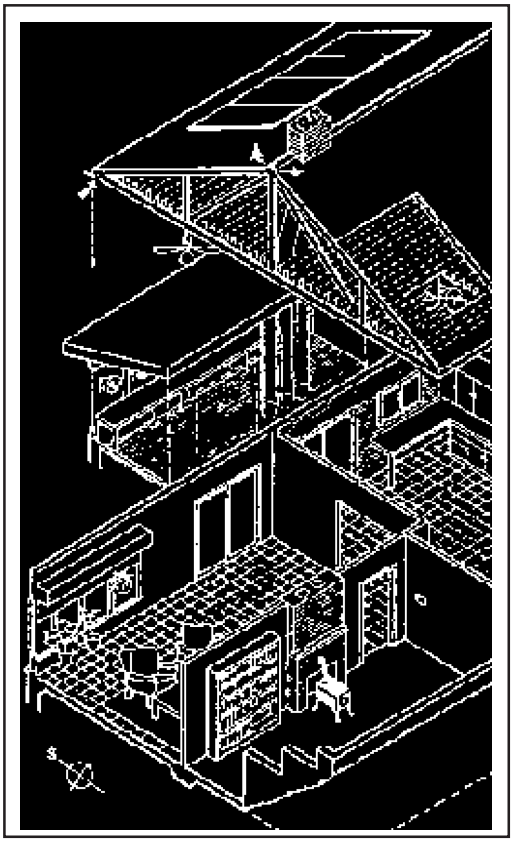


Comparing 5-Star Plus Home to Standard Home (2,000 square feet in Baton Rouge)	
Extra Construction Costs	$5,635
Additional Cost on Annual Mortgage (8% for 30 years)	$496
Annual Energy Savings	$1,045
Annual Internal Rate of Return	42%

PASSIVE SOLAR DESIGN

Passive solar design can be used with any style home. The design guidelines are simple and offer great flexibility. Properly designed passive solar homes provide comfort and energy savings at an affordable price. However, poorly planned homes can suffer from overheating, large temperature swings, and excessive glare.

Figure 2-5
Passive Solar Design



Elements of Passive Solar Design

1. **Energy Conservation Measures**—use an energy package such as 5-Star or 5-Star Plus.

2. **South-facing Windows** — let in 2 1/2 times more sunlight in winter and 2 1/2 times less in summer than east- and west-facing windows. Consider the increased comfort and energy savings that low-emissivity windows offer as explained in Chapter 6. See the chart below for sizing passive solar windows.

3. **Thermal Storage Mass** — tile-covered slab floors, masonry walls, water-filled containers, as well as conventional building materials and interior furnishings store heat and save energy in both summer and winter. The amount of mass needed for south windows is: 1.0 cubic foot (140 pounds) of masonry or 0.5 cubic foot (3.75 gallons) of water per square foot of south glass area over 7 percent of floor area.

4. **Heat Distribution Measures**—Open floor plans, vents, fans, and other measures help move solar-heated air between rooms in the building. Keep air distribution plans simple**.**

5. **Window Shading**—Overhangs, balconies, awnings, solar screens, and trees shade windows in summer.

6. **Ventilation**—Natural ventilation, ceiling fans, whole house fans, and space fans keep the house more comfortable in spring and fall. In summer, whole house fans may provide comfort, but often contribute too much humidity.

7. **Solar Water Heating**—Use the sun to provide part of the home's hot water needs.

Table 2-8
Sizing South Window Area for Passive Solar Homes
(Based on type of south window shading; expressed as percentage of floor area)*

	Unshaded	Overhang	Awning or Shade Screen	Shade Screen and Movable Insulation
Direct gain	0-5	5-12	5-16	5-20
Sunspace/solar greenhouse	5-10	5-20	5-25**	5-30

*For example, a 2,000-square-foot passive solar home with unshaded south glass should have at most 5% -- (0.05 * 2,000 = 100 square feet) of windows. If the direct gain area has solar shade screen, then the south glass area can increase to 16% of the floor area.

**If the area of south-facing glazing for a sunspace or solar greenhouse will exceed 20 percent of the floor area of the home, then it must be isolated from the rest of the house and not be air conditioned.